

FURTHER OBSERVATIONS

ON THE

Gustatory Organs of the Mammalia.

BY

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THE TONGUE OF *Petrogale lateralis*.

General Description. — The organ measures 78 mm. in length and 20 mm. in breadth. Anteriorly it is free from the frænum linguæ for 35 mm., or nearly half its length. The under surface

is marked by a longitudinal median ridge leading from the frænum to the tip, and the papillate surface is impressed anteriorly by a mesial groove. The fungiform papillæ are largest and most abundant at the sides of the organ, a little above the junction of the papillate and non-papillate surfaces. The greater part of the dorsum is beset (as usual in the Marsupialia) with closely packed papillæ of the compound filiform type. The circumvallate papillæ are three in number, and form an isosceles triangle. The posterior papilla is small, but clearly defined, and is distant about 15 mm. from the base of the tongue. The anterior papillæ are 8 mm. apart, and are very deeply set. Their apices barely reach the level of the lingual surface, and can be seen only by pressing apart the edges of the trenches. The region posterior to the triangle formed by the circumvallate papillæ is marked by a number of subparallel rugæ, which traverse the entire width of the dorsum. The lateral organs of taste are below the line formed by the junction of the two surfaces. They present a single row of minute openings. A short distance below the lateral organs is a longer but somewhat less regular row of openings. These are smaller than those of the lateral organ, and are spheroidal in shape. They are obviously the mouths of mucous ducts, the latter being very abundant in this region. Above the lateral organ, but at some distance from it, is the usual limiting fringe of filiform papillæ.

The Filiform Papillæ. — These papillæ follow the usual marsupial type (first described in detail by Poulton), and resemble quite closely those of *Phalangista*. They measure 0.3 mm. in diameter at the base, and are only 0.02 mm. apart. At the anterior limits of the middle third of the dorsum there are about fifteen papillæ to the square millimetre of surface. Each papilla breaks up into a number of secondary hair-like processes (usually nine), forming an incomplete ring round the outer portion of the main papillary trunk. Posteriorly the circle is not infrequently closed by a single process of much stouter growth and which is cornified at the tip.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — These papillæ exhibit the characters peculiar to the Marsupialia. They are more prim-

itive than those of *Perameles*, *Phascolomys*, and *Didelphys*, but are further advanced than in *Halmaturus*, *Macropus*, and *Belideus*. They approach quite closely *Phascolarctos*, *Bettongia*, and *Phalangista*. The general surface adjacent to the gustatory triangle is quite papillate. The posterior papilla is small, but clearly defined, and measures 0.85 mm. at the widest part. The anterior pair are elongated and deeply sunk, and their bases are slightly constricted. They measure 0.55 to 0.80 mm. transversely, and are 0.90 mm. in height. The trenches encircling them are uniformly narrow, their walls converging above, leaving only a narrow opening, in which the apex of the papilla is visible. Serous glands and ducts are fairly plentiful, the latter opening into the trenches at their deeper part. The results of Poulton's researches (*Proc. Zool. Soc.*, 1883, p. 609) on the tongue of *Petrogale xanthopus* are in some respects quite different from mine. He says: "The whole tongue is strikingly similar to *Macropus*, and, like it, follows the type of *Halmaturus*. The circumvallate papillæ are arranged in a similar triangle (the posterior angle being very obtuse), and nothing can be seen from the surface except the orifices of the involutions. The posterior papilla appears to be rather different from the anterior, the entrance being extremely small (probably contracted), and lies in the centre of a raised subcircular area, of which the surface is smooth. The anterior openings are larger (probably less contracted), and the raised area is less distinct." The variations in the papillæ of these two species of a common genus are certainly as marked as those which obtain between some species of different genera. The taste-bulbs of the posterior papilla are confined to its lateral area. They are disposed in several tiers, the mean number in a tier being eighty-five. They are closely set and remarkably uniform in size, measuring 0.060 mm. in length and 0.029 mm. in breadth. Non-medullated nerves and groups of small ganglia are present in the axial region of the papilla. The anterior papillæ bear bulbs on their summits as well as upon their lateral area. In the latter region there appear to be upwards of twenty tiers of them.

The Lateral Gustatory Organs. — These organs measure 4.50 mm. in length and 0.55 mm. in breadth. Each consists of five fairly regular folds, bearing bulbs on their lateral area. The furrows separating the folds are narrow, and average about 0.55

mm. in depth. Serous glands occur within the papillæ as well as beneath them, but are not abundant. Their ducts open into the furrows near the base of the folds. The bulbs are irregularly disposed at the sides of the folds, there being occasionally twelve or more successive tiers of them. I fail to detect any among the secondary papillæ of the upper part of the folds. The bulbs traverse the epithelium obliquely, and measure 0.056 mm. in length and 0.028 mm. in breadth.

The fungiform papillæ appear to be of normal structure, and are sparingly supplied with bulbs.

THE TONGUE OF *Tatusia novemcincta*.

General Description. — The tongue is long and narrow, and tapers gradually to a point. It measures 70 mm. in length, 16 mm. in breadth posteriorly, and is free from the frænum for 37 mm. The under surface possesses the usual longitudinal ridge. The upper anterior region is transversely grooved, and there is a deep median furrow at the base of the organ. The dorsum is quite densely papillate over most of its extent. The basal portion of the tongue bends rather abruptly downwards, as in *Dasypus sexcinctus* and *Dasypus villosus*. Papillæ of the fungiform type are sparingly scattered over the dorsum, and are also arranged in a single row at the sides, above the line of union of the upper and lower surfaces. The two circumvallate papillæ are on the same transverse line, 10 mm. apart, and 18 mm. from the base of the organ. The only indication of a lateral organ of taste is a small opening at each side of the dorsum, near the base of the tongue.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — Seen from above the papillæ are oval in shape. They measure 1.05 mm. in length, 0.75 mm. transversely, and 1 mm. in height. Their summits are rounded, and reach the level of the adjacent lingual surface. The trenches encircling them are narrow and deep. Glands of the serous type are not abundant. Their ducts open into the trenches at various levels, but the greater number discharge at or near the bases of the papillæ. Large and small non-medul-

lated nerve-fibres (and what appear to be isolated ganglion cells) are scattered through the intra-papillary stroma. The bulbs are disposed on the lateral area, sometimes nearly filling it. The number of tiers is about twenty, the mean number of bulbs in a tier being ninety. The bulbs are closely set, and measure 0.058 mm. in length and 0.030 mm. in breadth. A few scattered bulbs are present in the epithelium of the outer wall of the trench.

The Lateral Gustatory Organs. — These organs are simple in construction. Each consists of a single complete fold of the mucous membrane, bearing bulbs on its upper surface and on one of its lateral slopes. The fold measures 0.35 mm. transversely, and is 0.40 mm. in height. Serous glands are present, and penetrate deeply the muscular layer of the tongue. Their ducts, which are very plentiful, open into the furrows at different levels. It is evident here, I think, that the furrows have developed first from simple gland-ducts, and hence are primary, the folds being secondary. This accords with the view advanced by Poulton, as touching the lateral organ of Marsupialia. The organs are supplied with non-medullated nerves, and groups of ganglion cells are present in the axial portion of the folds. The bulbs measure 0.054 mm. in length and 0.030 mm. in breadth. A second but partly differentiated fold, adjacent to the bulb-bearing slope of the complete fold, is traversed by gland-ducts and well filled with bulbs.

In structure the fungiform papillæ are of the usual mammalian type, and are richly supplied with nerves. The bulbs are equal in size to any observed in the circumvallate papillæ, although they have fewer sensory cells. The compound filiform papillæ follow in the main the type observed in *D. villosus*.

THE TONGUE OF *Mus decumanus*.

General Description. — The organ shows two well-marked divisions, a more or less expanded anterior portion and an elevated posterior part. The anterior division is 16 mm. in length, 9 mm. in breadth, and is free from the floor of the mouth for 12 mm. The upper surface and sides of this division are covered with closely set, recurved filiform papillæ. A well-defined median groove, 8 mm. long, passes through the tip of

the organ, and is continued on to the under surface for a short distance. Fungiform papillæ are sparingly scattered over the dorsum. The raised posterior division of the tongue, more convex than the anterior, is 12 mm. in length and 8 mm. in breadth. The general character of the surface agrees with that of the anterior division. There is a single circumvallate papilla situated in the median line, 5 mm. from the base of the organ. As in *Fiber zibethicus* and *Hesperomys leucopus*, the trench is anteriorly incomplete. The lateral organs are but faintly visible, and lie anterior to the circumvallate papilla.

GUSTATORY STRUCTURES.

The Circumvallate Papilla. — The papilla measures 0.36 mm. in diameter and 0.50 mm. in height. The immediate area around it is unapillate. The summit is flattened or slightly rounded, and overtops somewhat the adjacent lingual surface. The walls are perpendicular or nearly so, and the trench narrow and deep. Serous glands are plentiful, and their ducts open into the trench at its deeper part. Mucous glands are also abundant in this region; and their ducts, which exceed in diameter those of the serous type, traverse the mucous membrane, and open obliquely on the free surface.

The taste-bulbs are present on the lateral area of the papilla and in the epithelium of the outer wall of the trench. They fill the sides of the papilla to within a short distance of the top, and they reach the same level on the outer wall. The number of tiers in each region appears to be ten. The average number of bulbs in a tier of the papilla is thirty, the average number in a tier of the outer wall being about forty. Owing to the trench being incomplete the number of bulbs is relatively decreased. They are fairly uniform in size and shape, and measure 0.060 mm. in length and 0.032 mm. in breadth. Occasionally, isolated bulbs occur on the upper surface of the circumvallate papilla in *Mus decumanus*.

The Lateral Gustatory Organs. — The organs are 1.15 mm. in length and 0.40 mm. in breadth. Each consists of three or four folds, all of which bear bulbs on their lateral area. The folds are separated by narrow furrows, slightly dilated at their base, and having an average depth of 0.20 mm. The mucosa com-

posing the body of each fold divides into two (more rarely three) fairly symmetrical lamellæ, the interspace being filled up to the general level with epithelium. Serous glands are not abundant in this region. Their ducts usually open at the bottom of the furrows. The bulbs are limited to the lower half or two-thirds of the lateral portion of the folds. They are disposed in three or four closely-set tiers, each tier containing about eight bulbs in its entire length. They measure 0.062 mm. in length and 0.032 mm. in breadth.

The Fungiform Papillæ. — These appear to be normal in size, shape, position, and structure. Each papilla, as already pointed out by Lovén, bears a single bulb at its upper part, the latter lying vertically, directly in the long axis of the papilla. In point of size they are smaller than those of the circumvallate and foliate papillæ. Bulbs are numerous on the posterior surface of the larynx.¹ They average only 0.036 mm. in length and 0.027 mm. in breadth.

THE TONGUE OF *Mus musculus*.

General Description. — The organ is flattened and expanded anteriorly, and raised posteriorly. The two divisions are of about equal length, the total length of the tongue being 13 mm. The free part of the organ is 5 mm. in length, the tip is obtuse, and the upper and lower surfaces are impressed by a median groove. The circumvallate papilla lies in the median line, close to the base of the organ. The trench is normally incomplete anteriorly, and, in some instances, I think, also posteriorly incomplete.

GUSTATORY STRUCTURES.

The Circumvallate Papilla. — The adjacent surface is unapillate. The papilla measures 0.23 mm. transversely, and is 0.25 mm. in height. The summit is slightly rounded, overtopping the adjacent lingual area, and the walls are perpendicular or nearly so. Serous and mucous glands are only fairly plentiful, the ducts of the former opening into the trench at its lower part. The bulbs are closely set, and, in the papilla, are disposed

¹ Where no mention is made of the larynx, it is to be understood that owing to lack of material, no investigation was possible.

round its lower portion in five to seven tiers, there being some thirty-five bulbs in a tier. In the outer wall the number of tiers is four or five, each tier containing about forty bulbs. They traverse the epithelium obliquely, and measure 0.045 mm. in length and 0.024 mm. in breadth. The lateral taste-organs are very simple, consisting usually of a single fold, in the walls of which a few bulbs are scattered. Serous glands are present beneath the fold, but are not abundant. The fungiform papillæ as in *M. decumanus*.

THE TONGUE OF *Sciuropterus volucella*.

General Description.—The total length of the organ is 17 mm., of which 5.5 mm. only is free portion. The tip is more pointed than in *Sciurus* generally. The anterior dorsal groove as usual. The circumvallate papillæ form the usual triangle (the posterior angle being very obtuse in my specimens). Lateral organs are present, but inconspicuous.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ.—The papillæ are about 0.25 mm. in height. Their upper surfaces are somewhat uneven, and do not rise perceptibly above the level of the adjacent area. Serous and mucous glands are very abundant, the former occurring within the papillæ as well as beneath and around them. Their ducts open into the trench at its deeper part. Bulbs are not very numerous. They are disposed in three to five tiers, the uppermost tier being about opposite the middle of the trench. They measure 0.048 mm. in length and 0.024 mm. in breadth.

The Lateral Gustatory Organs.—Each lateral organ consists of five fairly symmetrical folds. The furrows are quite uniform in breadth, and average 0.30 mm. in depth. The main body of the fold usually divides near the top into two portions, the depression between being filled by epithelium. Serous glands are plentiful, and their ducts open at or near the bottom of the furrows. The bulbs are for the most part limited to the lower half of the lateral wall of the fold. The average number of tiers is six. The bulbs measure 0.045 mm. in length and 0.021 mm. in breadth.

The fungiform papillæ appear to be of the usual type, and bear single bulbs at their upper part as in *Sciurus carolinensis* and *S. hudsonius*. The bulb lies vertically, directly in the long axis of the papilla, with its apex penetrating the outer layers of epithelium. They are uniformly smaller than those of the gustatory areas just considered, measuring 0.030 mm. in length and 0.018 mm. in breadth. I think there can be but little doubt of the presence of bulbs in the epiglottis. My material was not in good condition for thorough examination, but I am reasonably certain that I detected them. Further investigation, however, will be necessary to confirm this.

THE TONGUE OF *Manatus latirostris*.

General Description. — The tongue (that of a young individual) is 100 mm. long, of uniform breadth, and very thick. Anteriorly it is very much tied down, there being only about 10 mm. of free portion. The fore part of the dorsum is covered with an excessive development of long, delicate filiform papillæ. The circumvallate papillæ¹ measure from 0.60 to 1 mm. in diameter, and from 0.40 to 0.60 mm. in height. They are more or less flattened on top, and the trenches are not always complete. Glands (probably serous) are present beneath the papillæ. No regular arrangement of the bulbs was observed. They occur on the free surface of the papillæ, as well as on the lateral area, and are quite small, averaging only 0.04 mm. in length and 0.018 mm. in breadth. Here again fresh material will be necessary for a complete study of the gustatory structures.

THE TONGUE OF *Alces machlis*.

General Description. — The organ measures 260 mm. in length, 56 mm. in breadth, and is free from the frænum for 70 mm. Papillæ of the fungiform type are not abundant. The relatively small circumvallate papillæ are grouped in two main portions, on each side of the median line, at the posterior part

¹ According to Owen, *Comp. Anat. and Phys. of Verts.*, Vol. III., p. 195 (1868), the fossulate papillæ are numerous, extending on each side the dorsum from the anterior third to near the base of the tongue. I examined a great number of these papilliform elevations, but failed to find among them one true fossulate or circumvallate papilla.

of the dorsum. There are from eighteen to twenty papillæ on a side, some of which are obviously transitional forms. The lateral organs are wanting. The limiting fringe of filiform papillæ is present.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — The papillæ are flattened or rounded on top, and measure 0.90 mm. transversely and 1.20 mm. in height. At their upper part they bear many small secondary papillæ. Serous glands are not abundant. Their ducts open at the sides and bottom of the trenches. The taste-bulbs are not as numerous as one might be led to suppose from the large number of gustatory papillæ present. A few of them contain upwards of a dozen tiers, but in the majority of papillæ the disposition of the bulbs is quite irregular and, in some, bulbs appear to be altogether wanting. They measure from 0.060 to 0.070 mm. in length and 0.036 to 0.040 mm. in breadth.

The fungiform papillæ are normal, and bear one or more bulbs as usual. Between the circumvallate and fungiform types of papillæ are intermediate forms, bearing isolated bulbs either on their upper surface or upon their lateral area.

THE TONGUE OF *Cariacus virginianus*.

General Description. — The tongue is long and narrow, and measures 174 mm. in length, 35 mm. in breadth, and is free from the frænum for 62 mm. The posterior part of the dorsum, which is somewhat raised above the level of the anterior, is coarsely papillate, and falls off in the direction of the epiglottis. The anterior dorsal surface is impressed by a slight mesial groove, 43 mm. long, which terminates at the tip. The tip is obtuse, the under surface smooth, and the usual fleshy elevations project from the extreme basal region of the organ. The fungiform papillæ are small and uniformly distributed over the dorsum, those near the lateral margins blending with those of the circumvallate type. They are also thickly placed about the tip, especially its inferior aspect. There are thirteen circumvallate papillæ ranged on each side the median line, those most posteriorly placed being 30 mm. from the epiglottis. At the junction of the papillate with the non-papillate surface there is

a fringe consisting of simple or compound filiform papillæ, the apices of which are directed upwards and backwards. The fringe terminates anteriorly at a point opposite the frænum. No lateral gustatory structures were observed.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — The papillæ (a few of which are lobate) are flattened or slightly rounded on top, and their sides are vertical or nearly so. They are quite uniform in size, and measure 0.90 mm. transversely and 0.80 mm. in height. Serous glands are fairly plentiful, and their ducts discharge into the trenches at their deeper part. The arrangement and distribution of the gland-ducts is very regular and uniform, as may be seen from sections through the extreme basal portion of a papilla. A horizontal section made in this region divides the ducts transversely near their outlet, and shows them, usually twelve or thirteen in number, arranged in a ring. The taste-bulbs are disposed in several tiers, but the number varies greatly in different papillæ, some of them being crowded with bulbs, whilst others bear comparatively few. The average number of tiers is from ten to twelve, there being some sixty bulbs in a tier. They measure 0.063 mm. in length and 0.033 mm. in breadth.

The organ exhibits the intermediate or transitional forms of papillæ, so frequent a feature of the ruminant tongue.

Some of the papillæ are primitive in character, being deeply sunk and greatly sheltered by the converging walls of the trench. These simple ridges (for such they appear) bear bulbs over their entire convexity. The bulbs of the fungiform papillæ are rather small. The papillæ themselves are normal.

THE TONGUE OF *Cariacus toltecus*.

General Description. — The tongue is long and narrow, and measures 162 mm. in length. The width, which is quite uniform from the base to the tip, is 28 mm. Anteriorly it is free from the floor of the mouth for 56 mm. The posterior part of the organ is somewhat raised, and bears a trace of a median groove and is coarsely papillate. The extreme posterior region,

which falls away very abruptly to the base of the epiglottis, is slightly wrinkled but devoid of papillæ. The anterior dorsal surface is impressed by a mesial raphe for about half its length. The tip is obtuse, and the under surface smooth and marked by a slight ridge extending from the frænum to the tip. The fungiform papillæ of the anterior division are small and thinly scattered over the dorsum. Those of the raised posterior part are very much larger, and are enclosed between the two lateral groups of circumvallate papillæ. The latter, as usual, are grouped in two portions between the median line and lateral margins, those most posteriorly placed being 29 mm. from the base of the tongue. Of the ten or eleven papillæ on a side, several are intermediate forms. The tongue possesses a rudimentary lateral gustatory organ. The left lateral organ (the right one was undeveloped) consists of three or four partly differentiated folds, but is destitute of bulbs. The marginal fringe of papillæ was wanting.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — The papillæ are flattened on top, and their summits are slightly retracted at the centre. They vary greatly in size and general appearance. The larger ones measure 1.35 mm. transversely and 0.80 mm. in height. Serous glands are not abundant. The ducts open as usual. Many of the papillæ are but sparingly supplied with bulbs. A few of them possess six to ten tiers, there being about ninety bulbs in a tier. They measure 0.060 mm. in length and 0.036 mm. in breadth. Those of the fungiform papillæ are smaller, and measure 0.048 mm. in length and 0.030 mm. in breadth. A few bulb-like structures were observed in the epiglottis.

THE TONGUE OF *Bison americanus*.

General Description. — This specimen, of which the extreme posterior portion was wanting, measures 283 mm. in length, 85 mm. at the widest part, and is free for 100 mm. from the frænum. The anterior dorsal surface is beset with sharply pointed recurved cornified spines, similar to those of some of the Carnivora. The fungiform papillæ are thinly scattered over

the dorsum and are perhaps most numerous just above the line formed by the junction of the upper and lower lingual surfaces. On the raised or thickened posterior part of the organ there are eighteen circumvallate papillæ, arranged in two lines converging posteriorly. I could detect no trace of lateral gustatory structures.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — The papillæ are flattened on top, and their sides incline downwards and slightly inwards. They measure from 1.50 to 2 mm. transversely and are 1.40 mm. in height. Serous glands are not abundant. Their ducts open at the usual places. The exact number of tiers (not very great probably) I was unable to determine; but there appear to be in some tiers upwards of one hundred bulbs. They measure 0.069 mm. in length and 0.035 mm. in breadth. The bulbs of the fungiform papillæ are placed as usual.

THE TONGUE OF *Bibos indicus*.

General Description. — The free part is 100 mm. long, the total length of the organ being 265 mm. The tip is rounded, the under surface slightly wrinkled transversely, but unmarked by longitudinal ridge or grooves. The anterior dorsal surface is beset with retroverted cornified papillæ as in *B. americanus* and other Ruminantia. The fungiform papillæ are very prominent, and project so as to be readily felt when the dorsum is stroked. They are most abundant about the tip, thickly studing its margin and under part (the junction of the surface being beneath the tip). The circumvallate papillæ are grouped near the lateral borders of the thickened posterior part of the tongue, there being from seventeen to nineteen on a side including transitional forms. The lateral organs and marginal fringe were both wanting.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — The summits of these papillæ are flattened and expanded, while their bases are more or less constricted. Their sides are at first vertical, and then incline rather abruptly inwards. They measure 1.75 mm. transversely,

and are 1.10 mm. in height. The epithelium covering the upper surface is much thicker than that investing the lateral area, and at their upper part they bear many long, slender, secondary papillæ. Serous glands are not abundant, the ducts opening into the trenches, mostly at their deeper part. Bulbs occur at all parts of the lateral area. There are from ten to twenty tiers and some eighty or ninety bulbs in a well-filled tier. The bulbs measure 0.069 mm. in length and 0.036 mm. in breadth. The fungiform papillæ are very conspicuous, as already stated, and the larger ones are 1 mm. in height. The bulbs are plentiful, but of small size. In one papilla (probably in a transitional stage) I counted seventy-five bulbs embedded in the epithelium of the summit.

THE TONGUE OF *Ursus americanus*.

General Description. — In general appearance the tongue resembles that in *Canis* and *Vulpes*. The organ is long, and, from the base to the frænum, very thick. It measures 160 mm. in length, the breadth, which is nearly uniform, is 40 mm., and it is free from the floor of the mouth for 46 mm. The dorsum is impressed anteriorly by a well-marked mesial groove, which passes through the edge of the broad flattened tip. The under surface is smooth and ungrooved, and short, coarse, papillary processes project from the surface at the posterior end of the dorsum. The fungiform papillæ are very numerous, and resemble minute white beads. At the lateral margins, where they form a line, many have undergone structural modification, and probably here their function is wholly tactile. The circumvallate papillæ, twenty in number, are arranged in the form of a semicircle, the convexity of which looks towards the epiglottis. Quite frequently two, and occasionally even three, papillæ share an enclosing wall in common. The lateral organs of taste are at the junction of the papillate and non-papillate surfaces, at a point opposite the semicircle of circumvallate papillæ.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — The papillæ are frequently lobate. The summits project but a trifle, and all are slightly pitted or fissured at the centre. The larger ones are 2 mm.

in diameter and 1.40 mm. in height. Serous glands occur within the papillæ as well as beneath them, but are not abundant. Bulbs occur at all parts of the lateral area, and a few isolated ones are present on the upper surface. The number of tiers varies from fifteen to twenty, and there are about ninety bulbs in a tier. They measure 0.060 mm. in length and 0.030 mm. in breadth.

The Lateral Gustatory Organs.—These organs are about 11 mm. in length. The folds vary greatly in size and general appearance, and several of the furrows are incomplete. Serous glands and ducts are not abundant. Only four or five of the folds bear bulbs. There may be twenty tiers, but usually the number is less. The bulbs vary much in size, one with a very long neck measuring 0.090 mm. in length and 0.045 mm. in breadth. The mean dimensions are probably the same as for those of the circumvallate papillæ.

Bulbs were fairly plentiful in the fungiform papillæ. They are of good size, and measure 0.057 mm. in length and 0.026 mm. in breadth.

THE TONGUE OF *Ursus malayanus*.

General Description.—The organ measures 137 mm. in length, 35 mm. in breadth, and is free from the frænum for 42 mm. The under surface is smooth, and impressed by a faint median groove extending from the frænum to the tip. The tip is thin, flat, and expanded. The upper surface is marked anteriorly by a mesial raphe. Papillæ of the fungiform type are abundant, and quite evenly distributed over the dorsum. The extreme posterior dorsal surface bears the usual fleshy elevations. The circumvallate papillæ are arranged in a crescent, the convexity of which is turned towards the epiglottis. The lateral gustatory organs lie on either side of the tongue, close to the base.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ.—The papillæ vary much in size and shape, and some of them are lobate. They measure on the average 1.10 mm. in diameter and 0.80 mm. in height. Their summits are flattened, and project a trifle from the opening of the trench. The sides are at first vertical, and then curve

inwards, giving the papillæ somewhat constricted bases. The adjacent lingual area is smooth and unapillate. Serous glands are not very abundant. The bulbs fill the lower half or two-thirds of the lateral area of the papillæ, their under surface being crowded with them. The mean number of tiers is fifteen. The bulbs are closely set, and I have counted one hundred and ten in a tier, but the mean number is ninety-five. They measure 0.057 mm. in length and 0.033 mm. in breadth.

The Lateral Gustatory Organs. — These organs are 4.50 mm. long and 1.40 mm. wide. Each consists of four or five somewhat irregular folds. The furrows are dilated at the base, and measure 0.70 mm. in depth. Serous glands are not abundant, but occur within the folds. Their ducts open into the furrows at different levels. All of the folds bear bulbs on their lateral walls. The average number of tiers appears to be fifteen. They measure 0.056 mm. in length and 0.030 mm. in breadth. Bulbs are sparingly present in the fungiform papillæ.

THE TONGUE OF *Mustela erminea*.

The tongue is smaller than in *Putorius vison*, but both possess many of the same general characters. All of the fungiform papillæ examined contained bulbs, one usually being present at the upper part of each papilla. They measure 0.027 mm. in length and 0.016 mm. in breadth. Serous glands are not abundant. The circumvallate papillæ were not investigated.

THE TONGUE OF *Felis tigris*.

General Description. — The organ is 200 mm. in length, 66 mm. in breadth, and is free from the frænum for 65 mm. The anterior portion of the dorsum is beset with stout recurved cornified papillæ. The fungiform papillæ are thinly scattered over the dorsal surface, including the lateral portions and tip. A few fleshy papillæ project from the surface at the base of the organ. The tip is flattened and expanded, and the edge papillose. The under surface of the free part is smooth or slightly wrinkled, save the lateral portions, which are beset with papillæ similar in character to those of the basal region. The line of junction of the upper and lower surfaces at this point is beneath

the tongue, and is not sharply defined. The seven circumvallate papillæ are arranged in two lines converging backwards. No lateral gustatory structures were detected.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — The papillæ are small and rather deeply set, and are more or less lobate. They measure 1.90 mm. transversely, and are 1.30 mm. in height. The outer walls appear to have developed from the simple papillæ adjacent. Superimposed on some of the papillæ are two or more of the fungiform type. Single fungiform papillæ thus placed have already been observed in *Lepus*, *Castor* (Tuckerman), and *Sus* (Schwalbe). Serous glands are not abundant. Their ducts open into the trenches at the usual places. The bulbs are disposed on the lateral area in ten to twelve tiers, there being about one hundred bulbs in a tier. In the lobate papillæ the walls of the mid-trench are also filled with bulbs. Isolated bulbs likewise occur to some extent on the free surface of the papillæ. The superimposed fungiform papillæ usually bear a single small bulb at their upper part, the latter lying vertically, directly in the long axis of the papilla. They measure in this region 0.045 mm. in length and 0.024 mm. in breadth. The bulbs of the circumvallate papillæ are small for an animal of this size, measuring 0.060 mm. in length and 0.033 mm. in breadth.

THE TONGUE OF *Felis catus*.

General Description. — The organ measures 84 mm. in length, 30 mm. in breadth, and is free from the floor of the mouth for 30 mm. The anterior dorsal surface is flattened and beset with the usual long, hard, retroverted spines of the Carnivora. The papillæ do not extend to the tip, and cease some distance from the lateral margins. The tip is obtuse, and the edge, as in *F. domesticus*, is bordered with both small and large fungiform papillæ. The fungiform papillæ are scattered over the portion of anterior surface not sheathed with cornified papillæ. I detected but five papillæ of the circumvallate type. Of these, four (two of which, though not contiguous, possessed an enclosing wall in common) were on the same transverse line, and 19

mm. distant from the base of the organ. The fifth papilla lay directly in front of the double one, the latter being placed at the extreme left of the line. Behind the gustatory area numerous coarse fleshy papillæ project from the dorsum. The lateral organs of taste are rudimentary, and the fringe of filiform papillæ above them was not strongly marked.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ.—The papillæ are small and inconspicuous, and measure 0.85 mm. transversely and 0.90 mm. in height. Their summits are rounded, and the adjacent lingual surface somewhat papillate. Serous glands are not abundant, the ducts opening into the narrow trenches at the usual places. The distribution of the bulbs is far from regular, some of the papillæ having six or seven well-arranged tiers of them, whilst in other papillæ only isolated bulbs occur. The rudimentary taste-organs at the sides of the tongue consist of seven or eight well-formed folds of the mucosa, but they are destitute of bulbs, and no serous glands could be detected in the region.

Many of the fungiform papillæ bear bulbs at the usual places. For lack of material the epiglottis was not investigated in *F. catus*. Bulbs have been found, however, by the present writer on the anterior surface of the epiglottis in *Felis domesticus*, and other investigators, notably Schofield and Davis, have found them elsewhere in the larynx.

THE TONGUE OF *Felis pardalis*.

General Description.—The tongue measures 85 mm. in length, 27 mm. in breadth, and is free from the frænum for 45 mm. The dorsum is more or less roughened anteriorly, and the basal portion is beset with fleshy papillæ. Papillæ of the fungiform type are not abundant. There are three pairs of circumvallate papillæ. The posterior pair, quite prominent, are 3 mm. apart, and 17 mm. from the base of the organ. The anterior pair are 8 mm. distant from the posterior, and are 11 mm. apart. No lateral gustatory organs were detected. The material was not in a condition for minute examination.

THE TONGUE OF *Viverra civetta*.

General Description. — The organ measures 78 mm. in length, 21 mm. in breadth, and is free from the frænum for 20 mm. Anteriorly it is bordered by a fringe of delicate filiform papillæ. The tip is slightly bifurcate, and the under surface is impressed by a deep median groove extending from the frænum to the tip. Papillæ of the fungiform type are not numerous. The circumvallate papillæ are very indistinct, but there appear to be at least three (?), arranged in a triangle, the apex being turned backwards. The microscopical examination of the papillæ yielded only negative results.

THE TONGUE OF *Canis cinereo-argentatus*.

General Description. — The organ measures 63 mm. in length, 17 mm. in width, and is free from the floor of the mouth for 24 mm. The tip is obtuse, and the anterior third of the papillate surface is impressed by a mesial groove. The usual fleshy processes project from the basal region of the tongue. The fungiform papillæ are similar to those in *Vulpes vulgaris*, and resemble minute white beads. The circumvallate papillæ, five in number, are arranged in two lines converging posteriorly. Each is encircled by a slightly verrucose, fimbriated wall. The lateral organs of taste lie at the junction of the papillate and non-papillate surfaces, and are not concealed by a fringe of papillæ as in *V. vulgaris*.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — The papillæ are slightly verrucose at the summit, and the adjacent surface is papillate. They measure 0.85 mm. transversely and 0.70 mm. in height. The trenches are not very narrow, and the ducts of the serous glands open into them at their deeper part. The glands themselves are not very plentiful. The bulbs are disposed in twelve closely set tiers, filling the lower two-thirds of the lateral area. Each tier contains upwards of sixty bulbs. They measure 0.046 mm. in length and 0.024 mm. in breadth.

The Lateral Gustatory Organs. — These organs are about 5 mm. long and consist of some ten unequal folds, the majority

of which bear bulbs on their lateral walls. The furrows average in depth about 0.60 mm. Serous glands are scattered about within and beneath the folds. The ducts open for the most part at the bottom of the furrows. The bulbs (of which there may be twelve tiers) are irregularly disposed on the lateral walls, but are in the main confined to their lower two thirds. In size and general appearance they agree closely with those of the circumvallate papillæ.

Bulbs are plentiful in the fungiform papillæ. An unusually large one in this region measured 0.060 mm. in length and 0.030 mm. in breadth.

THE TONGUE OF *Canis mesomelas*.

General Description. — In general appearance the organ closely resembles that in *Canis familiaris*. It measures 100 mm. in length, 32 mm. in breadth, and is free for 35 mm. from the frænum. The upper surface is marked by a mesial raphe. The raphe, near the tip, is very distinct; but posteriorly it becomes gradually superficial, and before reaching the area of the circumvallate papillæ disappears altogether. The fungiform papillæ are small, but quite uniform in their distribution, and fairly abundant. The extreme posterior region of the tongue bears the usual fleshy papillæ. The tip is very slightly bifurcate, and the under surface somewhat wrinkled transversely. The five circumvallate papillæ are in two rows converging posteriorly. The small lateral gustatory structures are well forward, their posterior end being on a line with the anterior circumvallate papillæ. The marginal fringe of papillæ, usual at this point in many mammals, is wanting.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — The papillæ measure from 1.10 to 1.45 mm. transversely, and are 1 mm. in height. Their summits are verrucose, and some of the secondary papillæ terminate in partly cornified spines. The walls encircling them are narrow and deep, and are more or less fimbriated. It is evident, I think, that in some cases, if not in all, the outer walls have developed directly from the simple papillæ of the adjacent area. Serous glands are not abundant. Their ducts open into

the trenches at their base or deeper part. The bulbs are quite plentiful and to some extent occur in the outer wall of the trench. They are disposed on the lateral area of the papillæ in twelve tiers. They are closely set in the tiers, some of them containing upwards of one hundred and thirty bulbs. The mean number is probably one hundred. The bulbs are small and measure 0.045 mm. in length and 0.026 mm. in breadth.

The Lateral Gustatory Organs. — The organs are 4 mm. in length and 1 mm. in breadth. The folds, some of which are cleft at the summit, are quite irregular. The furrows are narrow throughout, but vary much in depth, the average depth being 0.70 mm. Serous glands occur within the folds and beneath them, but are not abundant. Their ducts open into the furrows at their lower part. The bulbs are limited to the lateral walls of the eight folds, where they are disposed in from ten to twelve tiers. The character of the epithelium of the summit of the folds is such as would render the development of bulbs in that region highly improbable if not impossible. They measure 0.045 mm. in length and 0.026 mm. in breadth.

The fungiform papillæ appear to be of normal structure. Those about the tip are small, but bear one or two bulbs at their upper part. In a papilla of the mid-dorsal region I have seen in vertical section a row of eight bulbs extending entirely across the summit. A well-developed bulb of this region measures 0.060 mm. in length and 0.032 mm. in breadth.

THE TONGUE OF *Lemur mongoz*.

General Description. — The organ measures 43 mm. in length, 18 mm. in breadth, and is free from the frænum for 14 mm. The under surface is impressed by a short but deep median groove extending in front of the frænum. Papillæ of the fungiform type are only sparingly scattered over the dorsum, but about the tip they are much more numerous, the edge and under portion being thickly studded with them. There are two pairs of circumvallate papillæ. The posterior pair are 1 mm. apart, and 7 mm. from the base of the organ. The anterior pair are 3.5 mm. distant from the posterior, and are 6.5 mm. apart. The lateral gustatory organs lie about as usual, their posterior end being on a line with the posterior pair of circumvallate papillæ.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — The papillæ are 1.10 mm. in diameter, and measure the same in height. Their summits are flattened, but overtop the adjacent lingual surface. Serous glands are not very plentiful. Their ducts open at or near the bottom of the trenches. The bulbs are numerous, but the number of tiers varies considerably in different papillæ. The mean range is from twelve to fifteen, the number of bulbs in a tier being about ninety. There is a very uniform decrease in the size of the bulbs from above downwards; that is, from the uppermost to the lowermost tier. The mean length is 0.050 mm., and the mean breadth .030 mm.

The Lateral Gustatory Organs. — The organs are 9 mm. in length. Of the twelve to fourteen folds, eight or nine are bulb-bearing. The furrows are fairly uniform in breadth, but vary in depth, the average depth being about 0.70 mm. Serous glands are more abundant here than in the circumvallate gustatory region. The sides of the folds are well filled with bulbs, there being sometimes as many as twenty tiers. They also occur, though sparingly, on the free upper surface. They are smaller in this gustatory area, only measuring 0.045 mm. in length and 0.024 mm. in breadth. The fungiform papillæ are normal in structure and are well supplied with bulbs, especially those of the tip. Bulbs also occur to some extent in the epiglottis.

THE TONGUE OF *Cebus hypoleucus*.

General Description. — The organ measures 40 mm. in length, 20 mm. in breadth, and is free from the frænum for 15 mm. There is a short mesial raphe on the anterior dorsal surface, and a deep median groove on the under surface of the free part, which becomes superficial at the tip. Fungiform papillæ of good size are sparingly but quite evenly distributed over the dorsum, sides, and tip, including its inferior portion. The circumvallate papillæ are three in number. They are arranged in the form of an equilateral triangle, with the apex turned towards the epiglottis. The lateral gustatory organs are clearly defined. The basal portion of the dorsum presents a rugous appearance. The limiting fringe of papillæ is wanting.

The frænal process or sublingual plate noted by Hunter in *Lemur mongos* (wanting, or overlooked, in my specimen), and subsequently observed by Owen in other Lemuridæ, is a lingual character in *Cebus*, *Macacus*, and *Ateles*. In *Cebus hypoleucus* the process is flattened, and bifurcate at the tip. It measures 9 mm. in length, and is 6 mm. in width at point of attachment to the frænum. Especial interest attaches to the frænal plate in *Ateles*, as it represents a hitherto undescribed bulb-bearing area.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — The summits of the papillæ are rounded and the adjacent region papillate. They measure 1.50 mm. transversely and 0.90 mm. in height. Serous glands are quite plentiful, occurring within the papillæ as well as beneath and around them. The ducts open at the deeper part of the trenches. There appear to be about ten tiers of bulbs, each tier containing on the average some ninety bulbs. They measure 0.045 mm. in length and 0.025 mm. in breadth.

The Lateral Gustatory Organs. — The organs are 5 mm. in length, and the depth of the furrows is about 1 mm. The seven folds are fairly regular and bear bulbs. Serous glands are abundant, and their ducts open into the furrows at different levels. The ducts of the intrapapillary glands occasionally open into the furrows above the level of the bulbs. The bulbs, of which there are from ten to fifteen tiers, are small and measure 0.044 mm. in length and 0.024 mm. in breadth. The fungiform papillæ bear bulbs, but not in great abundance. They are placed as usual.

THE TONGUE OF *Cercopithecus diana*.¹

General Description. — The organ measures 55 mm. in length, 21 mm. in breadth, and is free from the frænum for 15 mm. The under surface is impressed by a median groove extending from the frænum to the tip. Fungiform papillæ of fair size are thinly scattered over the dorsum. They are most abundant about the tip, including its marginal portion. The circumvallate

¹ Lately studied by Luigi Tavernari, but with what results is not known to the writer.

papillæ, three in number, are arranged in an isosceles triangle, the apex of the triangle being directed backwards. The lateral gustatory organs appear to lie normally. The frænal process, or sublingual plate, was lacking.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — The summits of the papillæ are smooth and flattened, and their sides are vertical. They measure 1.05 mm. transversely, and are 0.90 mm. in height. Serous glands are not abundant. The bulbs are disposed in some ten tiers, with ninety closely packed bulbs in a tier. They measure 0.051 mm. in length and 0.030 mm. in breadth.

The Lateral Gustatory Organs. — The organs measure 12 mm. in length and 2.5 mm. in breadth. The folds, eight or nine in number, are flattened on top, and the furrows average in depth 0.90 mm. Serous glands occur within the folds, but are not plentiful. Bulbs are here and there present on the upper surface of the folds, and their lateral walls usually contain many tiers. Their dimensions are the same as those given for the circumvallate papillæ.

The fungiform papillæ bear bulbs as usual, and they also occur at the lower part of the posterior surface of the epiglottis.

THE TONGUE OF *Ateles ater*.

General Description. — The organ measures 54 mm. in length, 20 mm. in breadth, and is free from the frænum for 12 mm. It is quite thick posteriorly, and the general surface is smooth and yielding to the touch. The under surface of the free portion is impressed by a deep wedge-shaped groove extending from the frænum to the tip. The fungiform papillæ are abundant only at the tip; beneath it, they are large and closely packed. As in *Lemur mongoz*, the circumvallate papillæ consist of two pairs. The posterior pair are 2.6 mm. apart, and 13 mm. from the base of the tongue. The anterior pair are well forward, being 10 mm. from the posterior pair and 11 mm. apart. The two pairs of papillæ, seen from above with a low power, show a marked difference in external characters. The summits of the posterior pair are smooth and circular. The anterior pair, on

the other hand, lie more obliquely, present a less regular contour, and are somewhat depressed at the centre. Within the space bounded by the four gustatory papillæ are three transitional forms, which are obviously modifications of the fungiform type. The dorsum posterior to the gustatory region is wrinkled, but devoid of papillæ. The lateral gustatory organs are placed obliquely at the sides of the base, very much as in *Lepus*. The fringe of filiform papillæ is wanting.

The tongue of *Ateles* possesses a frænal process very similar to that already described in *Cebus*. It measures 6.5 mm. in length, and its greatest width is 4.5 mm. The tip is forked, and the edge more or less fimbriated.

GUSTATORY STRUCTURES.

The Circumvallate Papillæ. — The papillæ vary greatly in size and are occasionally lobate. The summits of the anterior pair do not project from the openings of the trenches, and hence they are more protected than the posterior pair. They measure from 0.70 mm. to 2.30 mm. transversely, and are 0.75 mm. in height. Serous glands are fairly abundant and occur within the papillæ. The ducts open at the usual places. The bulbs are disposed on the lateral area of the papillæ in ten tiers. A few scattered bulbs are also present on the free upper surface and, more rarely, may be found embedded in the epithelium of the outer wall of the trench. The bulbs are closely set, and, in crowded tiers, number one hundred and forty. The mean is probably one hundred. They measure 0.051 mm. in length and 0.027 mm. in breadth.

The Lateral Gustatory Organs. — The organs are flattened or slightly rounded on top, and measure 8 mm. in length and 4.5 mm. in breadth. The folds are fairly uniform in size, and twelve of the fifteen bear bulbs. The furrows are narrow, and measure 0.65 mm. in depth. Serous glands are fairly plentiful and occur within the folds. The ducts open into the furrows at their deeper part. The bulbs, of which there are some ten tiers, measure 0.051 mm. in length and 0.027 mm. in breadth.

The fungiform papillæ are of normal structure. Those about the tip, more especially its under part, are richly supplied with bulbs. Here they are numerous but small, and in some papillæ

form a row of ten or more, which extends across the entire width of the summit.

I failed to detect terminal bulbs in the sublingual plate in *Cebus* or *Macacus*. In *Ateles*, however, they are quite numerous, especially in the fungiform papillæ, where I have counted as many as sixteen bulbs in a single vertical section. They are also imbedded in the epithelium of the free margin to some extent. One that I measured was 0.065 mm. in length; the average length, however, is 0.048 mm., the breadth being 0.030 mm. Non-medullated nerve-fibres enter the axes of the fungiform papillæ of the plate, and form a network beneath the bulb-bearing region. Glands, presumably of the mucous type, are present; there being a main central clump and, near each lateral border, a smaller one. It is highly probable, I think, that the sensory terminal organs of the sublingual plate are tactile rather than gustatory in function.

AMHERST, MASS., February, 1892.

